

DATE OF REPORT: 26TH MAY 2020



Adelaide Brighton Cement Ltd
PO Box 77
Port Adelaide SA 5015

TEST REPORT No. MAR20046.2

**AIR EMISSIONS MONITORING OF
RELEASE POINTS 4A & 4B AT
ADELAIDE BRIGHTON CEMENT LTD
IN BIRKENHEAD**

DATE OF TESTING: 17TH - 19TH MARCH 2020

ACCREDITATION:



This laboratory is accredited by the National Association of Testing Authorities (NATA).
NATA Accredited Laboratory No. 15463.
Accredited for compliance with ISO/IEC 17025:2005.
This document shall not be reproduced, except in full.

AUTHORISATION:

Mr. I.S. Brash *Adv.Dip.Mar.Eng.*
TECHNICAL MANAGER

Dr. C.M. Clunies-Ross *PhD(Chem.Eng.)*
LABORATORY MANAGER

TABLE OF CONTENTS

	Page
INTRODUCTION	4
QUALITY STATEMENT	5
TEST METHODS	6
DEFINITIONS	7
SUITABILITY OF SAMPLING PLANE	8 - 9
RESULTS – RELEASE POINT 4A – RUN 1	10 - 14
RESULTS - RELEASE POINT 4A – RUN 2	15 - 19
RESULTS – RELEASE POINT 4B – RUN 1	20 - 24
RESULTS - RELEASE POINT 4B – RUN 2	25 - 29

LIST OF TABLES

Table 1: Average Plant Operating Conditions during the Monitoring Program	5
Table 2: Summary of Test Methods	6
Table 3: Criteria for Selection of Sampling Planes	7
Table 4: Sampling Plane Details for the Kiln 4 Main Stack	8
Table 5: Sampling Plane Details for the Precalciner Plant Stack	9
Table 6: Release Point 4A (Run 1) - Gas Flow Conditions	10
Table 7: Release Point 4A (Run 1) - Summary of Test Results	11
Table 8: Comparison of Dioxin & Furan Concentration in 4A Stack (Run 1) with International Guideline	11
Table 9: Release Point 4A (Run 1) - Metals and their Compounds	12
Table 10: Release Point 4A (Run 1) - Individual USEPA Priority Pollutant PAHs	13
Table 11: Release Point 4A (Run 1) - Total USEPA Priority Pollutant PAHs	13
Table 12: Release Point 4A (Run 1) - Total PAH Toxic Equivalents (BaP-TEQ _{PAH})	13
Table 13: Release Point 4A (Run 1) – PCDD/F Congener Profile	14
Table 14: Release Point 4A (Run 2) - Gas Flow Conditions	15
Table 15: Release Point 4A (Run 2) - Summary of Test Results	16
Table 16: Comparison of Dioxin & Furan Concentration in 4A Stack (Run 2) with International Guideline	16
Table 17: Release Point 4A (Run 2) - Metals and their Compounds	17
Table 18: Release Point 4A (Run 2) - Individual USEPA Priority Pollutant PAHs	18
Table 19: Release Point 4A (Run 2) - Total USEPA Priority Pollutant PAHs	18
Table 20: Release Point 4A (Run 2) - Total PAH Toxic Equivalents (BaP-TEQ _{PAH})	18
Table 21: Release Point 4A (Run 2) – PCDD/F Congener Profile	19

TABLE OF CONTENTS Continued

LIST OF TABLES Continued

Page

Table 22: Release Point 4B (Run 1) - Gas Flow Conditions	20
Table 23: Release Point 4B (Run 1) - Summary of Test Results	21
Table 24: Comparison of Dioxin & Furan Concentration in 4B Stack (Run 1) with International Guideline	21
Table 25: Release Point 4B (Run 1) - Metals and their Compounds	22
Table 26: Release Point 4B (Run 1) - Individual USEPA Priority Pollutant PAHs	23
Table 27: Release Point 4B (Run 1) - Total USEPA Priority Pollutant PAHs	23
Table 28: Release Point 4B (Run 1) - Total PAH Toxic Equivalents (BaP-TEQ _{PAH})	23
Table 29: Release Point 4B (Run 1) – PCDD/F Congener Profile	24
Table 30: Release Point 4B (Run 2) - Gas Flow Conditions	25
Table 31: Release Point 4B (Run 2) - Summary of Test Results	26
Table 32: Comparison of Dioxin & Furan Concentration in 4B Stack (Run 2) with International Guideline	26
Table 33: Release Point 4B (Run 2) - Metals and their Compounds	27
Table 34: Release Point 4B (Run 2) - Individual USEPA Priority Pollutant PAHs	28
Table 35: Release Point 4B (Run 2) - Total USEPA Priority Pollutant PAHs	28
Table 36: Release Point 4B (Run 2) - Total PAH Toxic Equivalents (BaP-TEQ _{PAH})	28
Table 37: Release Point 4B (Run 2) – PCDD/F Congener Profile	29

LIST OF FIGURES

Figure 1: Kiln 4 Main Stack (RP 4A)	9
Figure 2: Precalciner Plant Stack (RP 4B)	9

INTRODUCTION

Airlabs Environmental Pty Ltd was commissioned by Adelaide Brighton Cement Ltd to conduct air emissions testing of the Dry Process Kiln 4 Main Stack (Release Point 4A) and the Pre-calciner Plant Stack (Release Point 4B) at their Birkenhead Plant. The following parameters were monitored in replicate on each stack:

- Gas velocity and volume flow rate
- Temperature
- Moisture concentration
- Concentration of oxygen & carbon dioxide
- Dry molecular weight and dry gas density
- Concentration and mass emission rate of:
 - Total solid particulates;
 - PM₁₀ (Particulate matter with a nominal aerodynamic diameter $\leq 10 \mu\text{m}$);
 - PM_{2.5} (Particulate matter with a nominal aerodynamic diameter $\leq 2.5 \mu\text{m}$);
 - Carbon monoxide;
 - Nitrogen oxides (NO, NO₂, NO_x);
 - Sulphur dioxide;
 - Antimony and its compounds (as Sb);
 - Arsenic and its compounds (as As);
 - Barium and its compounds (as Ba);
 - Beryllium and its compounds (as Be);
 - Cadmium and its compounds (as Cd);
 - Chromium trivalent and its compounds (as Cr(III));
 - Chromium hexavalent and its compounds (as Cr(VI));
 - Copper Oxide fume (as CuO);
 - Iron oxide fume (as Fe₂O₃);
 - Lead and its compounds (as Pb);
 - Magnesium oxide fume (as MgO);
 - Manganese and its compounds (as Mn);
 - Mercury and its compounds - organic and inorganic (as Hg);
 - Nickel and its compounds (as Ni);
 - Zinc oxide fume (as ZnO);
 - Hydrogen chloride (as HCl);
 - Fluoride (as HF);
 - Chlorine;
 - PAHs (as BaP toxic equivalent);
 - Polychlorinated Dibenzo-*p*-Dioxins & Polychlorinated Dibenzofurans (Dioxins & Furans);
 - Total Volatile Organic Compounds (TVOCs) as n-propane;
 - Benzene.

Combustion gases (O₂, CO, CO₂, SO₂ and NO_x) were monitored semi-continuously and the average values reported. Average normalised flow rates were used to calculate the mass emission rates. The Pre-calciner Plant Stack (4B) and the Dry Process Kiln 4 Main Stack (4A) were tested on the 17th - 19th March 2020.

QUALITY STATEMENT

Airlabs Environmental is committed to providing the highest quality data to all our clients, as reflected in our ISO 17025 (NATA) accreditation. This requires strict adherence to, and continuous improvement of, all our processes and test work. Our goal is to exceed the QA/QC requirements as set by our clients and appropriate governmental entities and to ensure that all data generated is scientifically valid and defensible.

Airlabs Environmental is NATA accredited for all sampling undertaken for this project. Analysis was undertaken by the National Measurement Institute (NATA Accreditation No. 198) and Airlabs Environmental in accordance with our terms of accreditation.

TEST METHODS

All sampling was undertaken by Airlabs Environmental. Airlabs Environmental is NATA accredited for all sampling undertaken for this project (NATA Accredited Laboratory No. 15463). Analysis was undertaken by Airlabs Environmental and the National Measurement Institute (NMI, NATA Accreditation No. 198) in accordance with our terms of accreditation. Specific details of the test methods used are available upon request.

Table 2: Summary of Test Methods

Test Parameter	Test Method	Method Detection Limit	Estimated Measurement Uncertainty	NATA Accredited	
				Sampling	Analysis
Sample plane criteria	AS 4323.1	N/A	N/A	✓	N/A
Gas velocity	US EPA Method 2	3 m/s	± 10%	✓	N/A
Temperature	US EPA Method 2	273K (0°C)	± 1%	✓	N/A
Moisture content	US EPA Method 4	0.2%	± 5%	✓	✓
Oxygen & carbon dioxide	US EPA Method 3A	0.1%	± 2%	✓	✓
Dry molecular weight & gas density	US EPA Method 3	N/A	± 5%	✓	✓
Total solid particulates ¹	AS 4323.2	1 mg/Nm ³	± 15%	✓	✓
PM ₁₀ & PM _{2.5}	US EPA Method 201A	1 mg/Nm ³	± 15%	✓	✓
Sulfur dioxide	US EPA Method 6C	3 mg/Nm ³	± 5%	✓	✓
Carbon monoxide	US EPA Method 10	1 mg/Nm ³	± 5%	✓	✓
Nitrogen oxides (as NO ₂)	US EPA Method 7E	2 mg/Nm ³	± 5%	✓	✓
Chlorine, Chloride (as HCl) & Fluoride (as HF)	US EPA Method 26	0.1 mg/Nm ³	± 17%	✓	✓ ²
Total VOCs	US EPA Method 25A	0.1 mg/Nm ³	± 10%	✓	✓
Benzene	US EPA Method 18 / NSW EPA TM-34	0.05 mg/Nm ³	± 17%	✓	✓
Multi-Metals	US EPA Method 29	0.05 mg/Nm ³ (total metals)	± 17%	✓	✓ ³
Chromium VI	US EPA Method 0061	0.0001 mg/Nm ³	± 17%	✓	✓ ⁴
PAHs (as BaP-TEQ _{PAH})	US EPA SW-846 Method 0010 & CARB 429	0.000005 mg/Nm ³ (total BaP-TEQ _{PAH})	± 20%	✓	✓ ⁵
Dioxins and Furans (PCDD/Fs)	USEPA Method 23	0.0004 ng/Nm ³ as I-TEQ	± 25%	✓	✓ ⁶

¹. Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2. US EPA 29 states that 'This method may be used to determine particulate emissions in addition to the metals emissions if the prescribed procedures and precautions are followed'.

². Chloride and fluoride analyses were performed by NMI, with results included in their Report No. RN1269402.

³. Multi-metal analysis was performed on the various sample components by NMI, with results included in their Report No. RN1272593.

⁴. Hexavalent chromium analysis was performed by NMI, with results included in their Report No. RN1269402.

⁵. PAH analysis was performed by NMI, with results included in their Analytical Certificate No. ORG20_020.

⁶. Dioxin & furan analysis was performed by NMI, with results included in their Analytical Certificate No. DAU20_108.

DEFINITIONS

'SA EPA'	South Australian Environment Protection Authority.
'US EPA'	United States Environmental Protection Agency.
'NSW EPA'	New South Wales Environment Protection Authority.
'NMI'	National Measurement Institute (Australian Government), North Ryde, NSW.
'K'	Absolute temperature in Kelvin ($^{\circ}\text{C} + 273$).
'mB'	Pressure in millibars.
'STP'	Standard temperature and pressure (273K and 101.3 kPa).
'm ³ '	Actual gas volume in cubic metres at stack conditions.
'Nm ³ '	Gas volume in dry cubic metres at STP.
'Sm ³ '	Gas volume in dry cubic metres at STP and referenced to 11% oxygen concentration.
'<'	Less than. The value stated is the limit of detection.
'g'	Grams.
'mg'	Milligrams (10^{-3} grams).
' μg '	Micrograms (10^{-6} grams).
'ng'	Nanograms (10^{-9} grams).
'min'	Minute.
'N/A'	Not applicable.
'PM ₁₀ '	Particulate matter with a nominal aerodynamic diameter $\leq 10 \mu\text{m}$.
'PM _{2.5} '	Particulate matter with a nominal aerodynamic diameter $\leq 2.5 \mu\text{m}$.
'LOD'	Limit of detection.
'FIA'	Flame ionisation analyser.
'VOC'	Volatile organic compound. A VOC is defined as any chemical compound based on carbon chains or rings with a vapour pressure greater than 2 mm of mercury (0.27 kPa) at 25 $^{\circ}\text{C}$. These compounds may contain hydrogen, oxygen, nitrogen and other elements, but specifically excluded are methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts.
'PAHs'	Polycyclic aromatic hydrocarbons.
'CARB'	California Air Resources Board.
'OEHHA'	Office of Environmental Health Hazard Assessment (US).
'BaP-PEF'	Benzo(a)pyrene Potency Equivalent Factor, as defined in "Benzo(a)pyrene as a Toxic Air Contaminant", CARB/OEHHA Executive Summary, July 1994.
'BAP-TEQ _{PAH} '	Benzo(a)pyrene Toxic Equivalents.
'PCDDs'	Polychlorinated Dibenzo-p-Dioxins.
'PCDFs'	Polychlorinated Dibenzofurans.
'TCDF'	Tetrachlorodibenzofuran.
'TCDD'	Tetrachlorodibenzo-p-dioxin.
'PeCDF'	Pentachlorodibenzofuran.
'PeCDD'	Pentachlorodibenzo-p-dioxin.
'HxCDF'	Hexachlorodibenzofuran.
'HxCDD'	Hexachlorodibenzo-p-dioxin.
'HpCDF'	Heptachlorodibenzofuran.
'HpCDD'	Heptachlorodibenzo-p-dioxin.
'OCDF'	Octachlorodibenzofuran.
'OCDD'	Octachlorodibenzo-p-dioxin.
'NATO'	North Atlantic Treaty Organisation.
'WHO'	World Health Organisation.
'NATO ₈₉ I-TEF'	International Toxic Equivalency Factor for PCDDs & PCDFs (NATO 1989 basis).
'NATO ₈₉ I-TEQ'	International Toxic Equivalent for PCDDs & PCDFs, based on the 2,3,7,8-TCDD congener (NATO 1989 basis).
'WHO ₀₅ TEF'	International Toxic Equivalency Factor for PCDDs & PCDFs (WHO 2005 basis).
'WHO ₀₅ TEQ'	International Toxic Equivalent for PCDDs & PCDFs, based on the 2,3,7,8-TCDD congener (WHO 2005 basis).

SUITABILITY OF SAMPLING PLANE

The criteria for sampling planes as specified in AS4323.1-1995 'Stationary Source Emissions, Method 1: Selection of Sampling Provisions' states that, in the absence of cyclonic flow activity, ideal sampling plane conditions are found to exist at the positions given in Table 3 below:

Table 3: Criteria for the Selection of Sampling Planes

Type of flow disturbance	Minimum distance upstream from disturbance, diameters (D)	Minimum distance downstream from disturbance, diameters (D)
Bend, connection, junction, direction change	>2D	>6D
Louvre, butterfly damper (partially closed or closed)	>3D	>6D
Axial fan	>3D	>8D (see Note)
Centrifugal fan	>3D	>6D

NOTE: The plane should be selected as far as practicable from a fan. Flow straighteners may be required to ensure the position chosen meets the check criteria listed in Items (a) to (f) below.

Section 4.1 of AS 4323.1-1995 (Ideal Sampling Positions) states that the location of the sampling plane shall be such that it meets the following criteria:

- (a) The gas flow is basically in the same direction at all points along each sampling traverse.
- (b) The gas velocity at all sampling points is greater than 3 m/s.
- (c) The gas flow profile at the sampling plane shall be steady, evenly distributed and not have a cyclonic component which exceeds an angle of 15° to the duct axis, when measured near the periphery of a circular sampling plane.
- (d) The temperature difference between adjacent points of the survey along each sampling traverse is less than 10% of the absolute temperature, and the temperature at any point differs by less than 10% from the mean.
- (e) The ratio of the highest to lowest pitot pressure difference shall not exceed 9:1 and the ratio of highest to lowest gas velocities shall not exceed 3:1. For isokinetic testing with the use of impingers, the gas velocity ratio across the sampling plane should not exceed 1.6:1.
- (f) The gas temperature at the sampling plane should preferably be above the dewpoint.

The gas characteristics determined for the Dry Process Kiln 4 Main Stack (Release Point 4A) and the Pre-calciner Plant Stack (Release Point 4B) satisfied the requirements of AS 4323.1-1995 Section 4.1 (a) - (f), and as such the sampling location is considered to be ideal. The sampling plane details and required number of sampling points are given in Tables 4 and 5 below:

SUITABILITY OF SAMPLING PLANE Continued

Table 4: Sampling Plane Details for the Kiln 4 Main Stack

Parameter	
Stack Shape	Circular
Actual Stack Internal Diameter (m)	3.23
Stack Exit Diameter (m)	3.23
Direction of Discharge to Air	Vertical
Type of Disturbance, Upstream	Centrifugal Fan
Distance from Upstream Disturbance	> 6 D
Type of Disturbance, Downstream	Stack Exit
Distance to Downstream Disturbance	> 2 D
Compliance with AS4323.1, Ideal Conditions	Yes
Stack Height Above Ground Level (m)	75.5
Standard No. of Sampling Points per Traverse	12
Number of Traverses	2
Correction Factor	N/A
Corrected No. of Sampling Points per Traverse	N/A
Total No. of Sampling Points	24
Stratified	No
Cyclonic	No (< 15°)
Velocity Difference	1.1:1 (< 1.6:1)
Absolute Temperature Difference (K)	< 10%
Minimum Velocity at any Sample Point (m/s)	> 3



Figure 1: Kiln 4 Main Stack (RP 4A)

Table 5: Sampling Plane Details for the Precaliner Plant Stack

Parameter	
Stack Shape	Circular
Actual Stack Internal Diameter (m)	3.00
Stack Exit Diameter (m)	3.00
Direction of Discharge to Air	Vertical
Type of Disturbance, Upstream	Centrifugal Fan
Distance from Upstream Disturbance	> 6 D
Type of Disturbance, Downstream	Stack Exit
Distance to Downstream Disturbance	> 2 D
Compliance with AS4323.1, Ideal Conditions	Yes
Stack Height Above Ground Level (m)	96
Standard No. of Sampling Points per Traverse	12
Number of Traverses	2
Correction Factor	N/A
Corrected No. of Sampling Points per Traverse	N/A
Total No. of Sampling Points	24
Stratified	No
Cyclonic	No (< 15°)
Velocity Difference	1.2:1 (< 1.6:1)
Absolute Temperature Difference (K)	< 10%
Minimum Velocity at any Sample Point (m/s)	> 3



Figure 2: Precaliner Plant Stack (RP 4B)

RESULTS – RELEASE POINT 4A – RUN 1

Company	Adelaide Brighton Cement
Site	Elder Rd, Birkenhead
Source Tested	Dry Process Kiln 4 Main Stack - Release Point 4A
Date of Tests	17 th March 2020
Sampling Period	07:42 – 15:23
Testing Officers	I. Brash & M. Portnoy
Sampling Position	Four 4" BSP sample ports in circular stack

Table 6: Release Point 4A (Run 1) - Gas Flow Conditions

Sampling Conditions	17/03/2020
Stack diameter at sampling plane (m)	3.23
Average stack gas temperature (K)	381 (108°C)
Average barometric pressure (mB)	1013.7
Average static pressure (mB)	-2.13
Average stack pressure (mB)	1011.6
Average velocity at sampling plane (m/s)	19.9
Average velocity at sampling plane expressed at STP (m/s)	14.3
Actual gas flow rate (m ³ /min)	9,780
Average moisture content (%v/v)	11.1
Gas flow rate at STP, dry (Nm ³ /min)	6,290
Gas flow rate at STP, dry and referenced to 11% O ₂ (Sm ³ /min)	3,050
Average carbon dioxide concentration, dry basis (%v/v)	4.94
Average oxygen concentration, dry basis (%v/v)	16.1
Dry molecular weight of stack gas (g/g mole)	29.43
Dry gas density of stack gas (kg/m ³)	1.313

RESULTS – RELEASE POINT 4A – RUN 1 Continued

Table 7: Release Point 4A (Run 1) - Summary of Test Results

Parameter	Sampling Period	Concentration (mg/Nm ³)	Emission Rate (g/min)
Total Solid Particulates	11:00 – 13:00 (17/03/2020)	6.9	48
PM ₁₀ Particles		5.5	38
PM _{2.5} Particles		2.8	19
Sulphur Dioxide	13:35 – 14:35 (17/03/2020)	< 3	< 20
Carbon Monoxide		6.8	47
Oxides of Nitrogen (as NO ₂) <i>Actual at STP</i>		880	5,540
Hydrogen Chloride	08:40 – 09:40 (17/03/2020)	0.79	4.9
Chlorine		0.58	3.6
Fluoride (as HF)		< 0.2	< 1
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	13:46 – 14:46 (17/03/2020)	2.0	14
Benzene (by activated carbon adsorption and GC/MS analysis)		< 0.07	< 0.5
Total Multi-Metals ^a	11:00 – 13:00 (17/03/2020)	0.38	2.4
Chromium VI and Compounds	13:23 – 15:23 (17/03/2020)	0.0010	0.0064
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ_{PAH}</i> ^b	07:42 – 10:42 (17/03/2020)	0.0000090	0.000057
Polychlorinated Dioxins and Furans ^c		0.14 ng/Nm ³ 0.0014 ng/Nm ³ 0.0016 ng/Nm ³	0.90 µg/min 0.0090 µg/min 0.010 µg/min
Total tetra to octa PCDDs/Fs ^d			
WHO ₀₅ TEQ for PCDDs/Fs ^d			
NATO ₈₉ I-TEQ for PCDDs/Fs ^d			

Table 8: Comparison of Dioxin & Furan Concentration in 4A Stack (Run 1) with International Guideline

Parameter	Concentration in Stack Gas Emissions (ng/Nm ³)	Oxygen (O ₂) Reference Condition (%)	Concentration at O ₂ Reference Condition (ng/Sm ³)	International Guideline (ng/Sm ³) ^e	Compliance with International Guideline
Polychlorinated Dioxins & Furans (NATO ₈₉ I-TEQ)	0.0016	11	0.0037	0.1	YES

^a Individual metals and their compounds are provided in Table 9. Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2 (refer to Table 2 'Summary of Test Methods').

^b Individual BaP-TEQ_{PAH} contributions are given in Table 10, and the total BaP-TEQ_{PAH} in Table 12. This result includes half LOD values.

^c Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 13.

^d Result includes half LOD values.

^e The International Guideline for the Concentration of Polychlorinated Dioxins & Furans in Stack Gas Emissions is 0.1 ng/Sm³ I-TEQ referenced to 11% O₂.

RESULTS – RELEASE POINT 4A – RUN 1 Continued

Table 9: Release Point 4A (Run 1) - Metals and their Compounds

Metal	Concentration (mg/Nm ³)	Emission Rate (g/min)
Antimony and its compounds	< 0.0003	< 0.002
Arsenic and its compounds	0.00012	0.00078
Barium (soluble compounds)	0.0015	0.0092
Beryllium and its compounds	< 0.0003	< 0.002
Cadmium and its compounds	< 0.00004	< 0.0003
Chromium (III) and its compounds	0.0019	0.012
Copper oxide fume (as CuO)	0.0024	0.015
Iron oxide fume (as Fe ₂ O ₃)	0.28	1.7
Lead and its compounds	0.00073	0.0046
Magnesium oxide fume (as MgO)	0.044	0.28
Manganese and its compounds	0.0058	0.037
Mercury and its compounds (as Hg)		
Organic:	< 0.00004	< 0.0003
Inorganic:	0.0021	0.013
Total ^f :	0.0021	0.013
Nickel and its compounds	0.038	0.24
Zinc oxide fume (as ZnO)	0.010	0.062
TOTAL METALS Excluding LOD values Including half LOD values	0.38	2.4

^f Total does not include 'less than limit of detection' value for organic mercury.

RESULTS – RELEASE POINT 4A – RUN 1 Continued

Table 10: Release Point 4A (Run 1) - Individual USEPA Priority Pollutant PAHs

Individual USEPA Priority Pollutant PAHs	Concentration of PAHs ($\mu\text{g}/\text{Nm}^3$)	BaP-PEF value	BaP-TEQ _{PAH} Contribution	Emission Rate of PAHs (mg/min)
Naphthalene	6.5	0.0	0.0	41
2-Methylnaphthalene	0.43	0.0	0.0	2.7
Acenaphthylene	<0.01	0.0	0.0	<0.06
Acenaphthene	<0.01	0.0	0.0	<0.06
Fluorene	0.011	0.0	0.0	0.069
Phenanthrene	0.11	0.0	0.0	0.72
Anthracene	<0.01	0.0	0.0	<0.06
Fluoranthene	0.042	0.0	0.0	0.26
Pyrene	0.019	0.0	0.0	0.12
Benz(a)anthracene	<0.01	0.1	0.0005	<0.06
Chrysene	<0.01	0.01	0.00005	<0.06
Benzo(b)fluoranthene	<0.01	0.1	0.0005	<0.06
Benzo(k)fluoranthene	<0.01	0.1	0.0005	<0.06
Benzo(e)pyrene	<0.01	0.0	0.0	<0.06
Benzo(a)pyrene	<0.01	1.0	0.005	<0.06
Perylene	<0.01	0.0	0.0	<0.06
Indeno(123-cd)pyrene	<0.01	0.1	0.0005	<0.06
Dibenz(ah)anthracene	<0.01	0.4	0.002	<0.06
Benzo(ghi)perylene	<0.01	0.0	0.0	<0.06

Table 11: Release Point 4A (Run 1)- Total USEPA Priority Pollutant PAHs

Total USEPA Priority Pollutant PAHs	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
<i>Excluding LOD values</i>	7.1	45
<i>Including half LOD values</i>	7.2	45

Table 12: Release Point 4A (Run 1) - Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ⁹	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
<i>Excluding LOD values</i>	0.0	0.0
<i>Including half LOD values</i>	0.0090	0.057

⁹ Calculated using benzo(a)pyrene potency equivalency factors (BaP-PEF values).

RESULTS – RELEASE POINT 4A – RUN 1 Continued

Table 13: Release Point 4A (Run 1) - PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm ³)	WHO ₀₅ TEF	WHO ₀₅ TEQ contribution (ng/Nm ³)	NATO ₈₉ I-TEF	NATO ₈₉ I-TEQ contribution (ng/Nm ³)
2378 TCDF	<0.0015	0.1	0.000075	0.1	0.000075
2378 TCDD	<0.00050	1	0.00025	1	0.00025
12378 PeCDF	0.0012	0.03	0.000037	0.05	0.000062
23478 PeCDF	0.0011	0.3	0.00034	0.5	0.00057
12378 PeCDD	<0.00045	1	0.00022	0.5	0.00011
123478 HxCDF	0.00095	0.1	0.000095	0.1	0.000095
123678 HxCDF	0.00080	0.1	0.000080	0.1	0.000080
234678 HxCDF	0.00090	0.1	0.000090	0.1	0.000090
123789 HxCDF	<0.00050	0.1	0.000025	0.1	0.000025
123478 HxCDD	<0.00045	0.1	0.000022	0.1	0.000022
123678 HxCDD	0.00047	0.1	0.000047	0.1	0.000047
123789 HxCDD	<0.00045	0.1	0.000022	0.1	0.000022
1234678 HpCDF	0.0038	0.01	0.000038	0.01	0.000038
1234789 HpCDF	0.00065	0.01	0.0000065	0.01	0.0000065
1234678 HpCDD	0.0065	0.01	0.000065	0.01	0.000065
OCDF	0.0030	0.0003	0.00000091	0.001	0.0000030
OCDD	0.030	0.0003	0.0000090	0.001	0.000030
PCDD/F Homologue Groups				Concentration (ng/Nm³)	
Total TCDF isomers				< 0.044	
Total TCDD isomers				< 0.0049	
Total PeCDF isomers				< 0.017	
Total PeCDD isomers				< 0.0037	
Total HxCDF isomers				< 0.0075	
Total HxCDD isomers				< 0.0090	
Total HpCDF isomers				0.0080	
Total HpCDD isomers				< 0.015	
Polychlorinated Dioxins & Furans Results Summary				Concentration (ng/Nm³)	Emission Rate (µg/min)
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.14	0.90
Total PCDD/F (Including half LOD values)				0.14	0.90
WHO ₀₅ TEQ (Total of WHO ₀₅ TEQ contribution for 17 toxic congeners)					
WHO ₀₅ TEQ (Excluding LOD values)				0.00081	0.0051
WHO ₀₅ TEQ (Including half LOD values)				0.0014	0.0090
NATO ₈₉ I-TEQ (Total of NATO ₈₉ I-TEQ contribution for 17 toxic congeners)					
NATO ₈₉ I-TEQ (Excluding LOD values)				0.0011	0.0069
NATO ₈₉ I-TEQ (Including half LOD values)				0.0016	0.010

RESULTS – RELEASE POINT 4A – RUN 2

Company	Adelaide Brighton Cement
Site	Elder Rd, Birkenhead
Source Tested	Dry Process Kiln 4 Main Stack - Release Point 4A
Date of Tests	17 th & 18 th March 2020
Sampling Period	15:38 – 19:55 (17/03/20) & 07:39 – 10:39 (18/03/20)
Testing Officers	I. Brash & M. Portnoy
Sampling Position	Four 4” BSP sample ports in circular stack

Table 14: Release Point 4A (Run 2) - Gas Flow Conditions

<i>Sampling Conditions</i>	<i>17/03/2020</i>	<i>18/03/2020</i>
Stack diameter at sampling plane (m)	3.23	3.23
Average stack gas temperature (K)	380 (107°C)	379 (106°C)
Average barometric pressure (mB)	1017.5	1015.8
Average static pressure (mB)	-1.64	-1.70
Average stack pressure (mB)	1013.5	1014.1
Average velocity at sampling plane (m/s)	19.6	19.5
Average velocity at sampling plane expressed at STP (m/s)	14.1	14.0
Actual gas flow rate (m ³ /min)	9,640	9,340
Average moisture content (%v/v)	12.1	9.95
Gas flow rate at STP, dry (Nm ³ /min)	6,090	5,940
Gas flow rate at STP, dry and referenced to 11% O ₂ (m ³ /min)	3,080	2,640
Average carbon dioxide concentration, dry basis (%v/v)	4.55	5.32
Average oxygen concentration, dry basis (%v/v)	15.9	16.3
Dry molecular weight of stack gas (g/g mole)	29.36	29.50
Dry gas density of stack gas (kg/m ³)	1.310	1.317

RESULTS – RELEASE POINT 4A – RUN 2 Continued

Table 15: Release Point 4A (Run 2) - Summary of Test Results

Parameter	Sampling Period	Concentration (mg/Nm ³)	Emission Rate (g/min)
Total Solid Particulates	17:55 – 19:55 (17/03/2020)	10	61
PM ₁₀ Particles		7.9	43
PM _{2.5} Particles		3.5	21
Sulphur Dioxide	08:07 – 09:07 (18/03/2020)	< 3	< 20
Carbon Monoxide		7.1	42
Oxides of Nitrogen (as NO ₂) <i>Actual at STP</i>		840	4,990
Hydrogen Chloride	16:09 – 17:09 (17/03/2020)	0.64	3.9
Chlorine		0.21	1.3
Fluoride (as HF)		< 0.2	< 1
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	09:21 – 10:21 (18/03/2020)	1.2	7.1
Benzene (by activated carbon adsorption and GC/MS analysis)		<0.07	<0.4
Total Multi-Metals ^h	17:55 – 19:55 (17/03/2020)	0.40	2.4
Chromium VI and Compounds	15:38 – 17:38 (17/03/2020)	0.0024	0.014
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ_{PAH}</i> ⁱ	07:39 – 10:39 (18/03/2020)	0.000010	0.000059
Polychlorinated Dioxins and Furans ⁱ		0.12 ng/Nm ³ 0.00098 ng/Nm ³ 0.0011 ng/Nm ³	0.72 µg/min 0.0058 µg/min 0.0068 µg/min
Total tetra to octa PCDDs/Fs ^k			
WHO ₀₅ TEQ for PCDDs/Fs ^d			
NATO ₈₉ I-TEQ for PCDDs/Fs ^d			

Table 16: Comparison of Dioxin & Furan Concentration in 4A Stack (Run 2) with International Guideline

Parameter	Concentration in Stack Gas Emissions (ng/Nm ³)	Oxygen (O ₂) Reference Condition (%)	Concentration at O ₂ Reference Condition (ng/Sm ³)	International Guideline (ng/Sm ³) ^l	Compliance with International Guideline
Polychlorinated Dioxins & Furans (NATO ₈₉ I-TEQ)	0.0011	11	0.0024	0.1	YES

^h Individual metals and their compounds are given in Table 17. Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2 (refer to Table 2 'Summary of Test Methods').

ⁱ Individual BaP-TEQ_{PAH} contributions are given in Table 18, and the total BaP-TEQ_{PAH} in Table 20. This result includes half LOD values.

^j Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 21.

^k Result includes half LOD values.

^l The International Guideline for the Concentration of Polychlorinated Dioxins & Furans in Stack Gas Emissions is 0.1 ng/Sm³ I-TEQ referenced to 11% O₂.

RESULTS – RELEASE POINT 4A – RUN 2 Continued

Table 17: Release Point 4A (Run 2) - Metals and their Compounds

Metal	Concentration (mg/Nm³)	Emission Rate (g/min)
Antimony and its compounds	< 0.0003	< 0.002
Arsenic and its compounds	0.00014	0.00088
Barium (soluble compounds)	0.0011	0.0068
Beryllium and its compounds	< 0.0003	< 0.002
Cadmium and its compounds	< 0.00004	< 0.0003
Chromium (III) and its compounds	0.0014	0.0088
Copper oxide fume (as CuO)	0.0017	0.011
Iron oxide fume (as Fe ₂ O ₃)	0.32	2.0
Lead and its compounds	0.00060	0.0037
Magnesium oxide fume (as MgO)	0.058	0.35
Manganese and its compounds	0.0049	0.030
Mercury and its compounds (as Hg)		
Organic:	< 0.00004	< 0.0002
Inorganic:	0.022	0.13
Total ^m :	0.022	0.13
Nickel and its compounds	0.0014	0.0086
Zinc oxide fume (as ZnO)	0.0092	0.056
TOTAL METALS Excluding LOD values Including half LOD values	0.40	2.4

^m Total does not include 'less than limit of detection' value for organic mercury.

RESULTS – RELEASE POINT 4A – RUN 2 Continued

Table 18: Release Point 4A (Run 2) - Individual USEPA Priority Pollutant PAHs

Individual USEPA Priority Pollutant PAHs	Concentration of PAHs ($\mu\text{g}/\text{Nm}^3$)	BaP-PEF value	BaP-TEQ _{PAH} Contribution	Emission Rate of PAHs (mg/min)
Naphthalene	10	0.0	0.0	61
2-Methylnaphthalene	0.37	0.0	0.0	2.2
Acenaphthylene	<0.01	0.0	0.0	<0.06
Acenaphthene	<0.01	0.0	0.0	<0.06
Fluorene	0.16	0.0	0.0	0.94
Phenanthrene	0.087	0.0	0.0	0.52
Anthracene	<0.01	0.0	0.0	<0.06
Fluoranthene	0.025	0.0	0.0	0.15
Pyrene	<0.01	0.0	0.0	<0.06
Benz(a)anthracene	<0.01	0.1	0.0005	<0.06
Chrysene	<0.01	0.01	0.00005	<0.06
Benzo(b)fluoranthene	<0.01	0.1	0.0005	<0.06
Benzo(k)fluoranthene	<0.01	0.1	0.0005	<0.06
Benzo(e)pyrene	<0.01	0.0	0.0	<0.06
Benzo(a)pyrene	<0.01	1.0	0.005	<0.06
Perylene	<0.01	0.0	0.0	<0.06
Indeno(123-cd)pyrene	<0.01	0.1	0.0005	<0.06
Dibenz(ah)anthracene	<0.01	0.4	0.0022	<0.06
Benzo(ghi)perylene	<0.01	0.0	0.0	<0.06

Table 19: Release Point 4A (Run 2) - Total USEPA Priority Pollutant PAHs

Total USEPA Priority Pollutant PAHs	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
<i>Excluding LOD values</i>	11	65
<i>Including half LOD values</i>	11	65

Table 20: Release Point 4A (Run 2) - Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ⁿ	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
<i>Excluding LOD values</i>	0.0	0.0
<i>Including half LOD values</i>	0.010	0.059

ⁿ Calculated using benzo(a)pyrene potency equivalency factors (BaP-PEF values).

RESULTS – RELEASE POINT 4A – RUN 2 Continued

Table 21: Release Point 4A (Run 2) - PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm ³)	WHO ₀₅ TEF	WHO ₀₅ TEQ contribution (ng/Nm ³)	NATO ₈₉ I-TEF	NATO ₈₉ I-TEQ contribution (ng/Nm ³)
2378 TCDF	<0.0011	0.1	0.000054	0.1	0.000054
2378 TCDD	<0.00038	1	0.00019	1	0.00019
12378 PeCDF	0.00087	0.03	0.000026	0.05	0.000043
23478 PeCDF	0.00087	0.3	0.00026	0.5	0.00043
12378 PeCDD	<0.00027	1	0.00014	0.5	0.000068
123478 HxCDF	0.00046	0.1	0.000046	0.1	0.000046
123678 HxCDF	0.00051	0.1	0.000051	0.1	0.000051
234678 HxCDF	0.00060	0.1	0.000060	0.1	0.000060
123789 HxCDF	<0.00043	0.1	0.000022	0.1	0.000022
123478 HxCDD	<0.00033	0.1	0.000016	0.1	0.000016
123678 HxCDD	<0.00033	0.1	0.000016	0.1	0.000016
123789 HxCDD	<0.00033	0.1	0.000016	0.1	0.000016
1234678 HpCDF	0.0021	0.01	0.000021	0.01	0.000021
1234789 HpCDF	0.00049	0.01	0.0000049	0.01	0.0000049
1234678 HpCDD	0.0042	0.01	0.000042	0.01	0.000042
OCDF	0.0016	0.0003	0.00000047	0.001	0.0000016
OCDD	0.053	0.0003	0.000016	0.001	0.000053
PCDD/F Homologue Groups				Concentration (ng/Nm³)	
Total TCDF isomers				0.025	
Total TCDD isomers				0.0020	
Total PeCDF isomers				0.012	
Total PeCDD isomers				0.0038	
Total HxCDF isomers				0.0048	
Total HxCDD isomers				0.0065	
Total HpCDF isomers				0.0047	
Total HpCDD isomers				0.0087	
Polychlorinated Dioxins & Furans Results Summary				Concentration (ng/Nm³)	Emission Rate (µg/min)
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.12	0.72
Total PCDD/F (Including half LOD values)				0.12	0.72
WHO ₀₅ TEQ (Total of WHO ₀₅ TEQ contribution for 17 toxic congeners)					
WHO ₀₅ TEQ (Excluding LOD values)				0.00053	0.0031
WHO ₀₅ TEQ (Including half LOD values)				0.00098	0.0058
NATO ₈₉ I-TEQ (Total of NATO ₈₉ I-TEQ contribution for 17 toxic congeners)					
NATO ₈₉ I-TEQ (Excluding LOD values)				0.00076	0.0045
NATO ₈₉ I-TEQ (Including half LOD values)				0.0011	0.0068

RESULTS – RELEASE POINT 4B – RUN 1

Company	Adelaide Brighton Cement
Site	Elder Rd, Birkenhead
Source Tested	Precalciner Plant Stack - Release Point 4B
Date of Tests	18 th March 2020
Sampling Period	12:29 – 20:21
Testing Officers	I. Brash & M. Portnoy
Sampling Position	Four 4" BSP sample ports in circular stack

Table 22: Release Point 4B (Run 1) - Gas Flow Conditions

<i>Sampling Conditions</i>	<i>Average</i>
Stack diameter at sampling plane (m)	3.00
Average stack gas temperature (K)	378 (105 °C)
Average barometric pressure (mB)	1009.6
Static pressure (mB)	-2.26
Average stack pressure (mB)	1007.3
Average velocity at sampling plane (m/s)	18.6
Average velocity at sampling plane expressed at STP (m/s)	13.4
Actual gas flow rate (m ³ /min)	7,880
Average moisture content (%v/v)	17.6
Gas flow rate at STP, dry (Nm ³ /min)	4,690
Gas flow rate at STP, dry and referenced to 11% O ₂ (Sm ³ /min)	5,310
Average carbon dioxide concentration, dry basis (%v/v)	20.4
Average oxygen concentration (%v/v), dry basis	9.70
Dry molecular weight of stack gas (g/g mole)	31.65
Dry gas density of stack gas (kg/m ³)	1.412

RESULTS – RELEASE POINT 4B – RUN 1 Continued

Table 23: Release Point 4B (Run 1) - Summary of Test Results

Parameter	Sampling Period	Concentration (mg/Nm ³)	Emission Rate (g/min)
Total Solid Particulates	18:21 – 20:21 (18/03/2020)	3.7	17
PM ₁₀ Particles	18:21 – 20:21 (18/03/2020)	3.0	14
PM _{2.5} Particles		1.6	7.5
Sulphur Dioxide	12:55 – 13:55 (18/03/2020)	<3	<10
Carbon Monoxide		610	2,860
Oxides of Nitrogen (as NO ₂) <i>Actual at STP</i>		540	2,530
Hydrogen Chloride	16:13 – 17:13 (18/03/2020)	0.23	1.1
Chlorine		0.11	0.50
Fluoride (as HF)		<0.2	<0.9
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	14:04 – 15:04 (18/03/2020)	3.0	14
Benzene (by activated carbon adsorption and GC/MS analysis)		<0.09	<0.4
Total Multi-Metals ^o	18:21 – 20:21 (18/03/2020)	0.37	1.7
Chromium VI and Compounds	15:48 – 17:48 (18/03/2020)	<0.0004	<0.002
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ_{PAH}</i> ^p	12:29 – 15:29 (18/03/2020)	0.000010	0.000047
<i>Polychlorinated Dioxins and Furans</i> ^q		0.22 ng/Nm ³ 0.0016 ng/Nm ³ 0.0020 ng/Nm ³	1.0 µg/min 0.0074 µg/min 0.0092 µg/min
Total tetra to octa PCDDs/Fs ^r			
WHO ₀₅ TEQ for PCDDs/Fs ^j			
NATO ₈₉ I-TEQ for PCDDs/Fs ^j			

Table 24: Comparison of Dioxin & Furan Concentration in 4B Stack (Run 1) with International Guideline

Parameter	Concentration in Stack Gas Emissions (ng/Nm ³)	Oxygen (O ₂) Reference Condition (%)	Concentration at O ₂ Reference Condition (ng/Sm ³)	International Guideline (ng/Sm ³) ^s	Compliance with International Guideline
Polychlorinated Dioxins & Furans (NATO ₈₉ I-TEQ)	0.0020	11	0.0017	0.1	YES

^o Individual metals and their compounds are given in Table 25. Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2 (refer to Table 2 'Summary of Test Methods').

^p Individual BaP-TEQ_{PAH} contributions are given in Table 26, and the total BaP-TEQ_{PAH} in Table 28. This result includes half LOD values.

^q Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 29.

^r Result includes half LOD values.

^s The International Guideline for the Concentration of Polychlorinated Dioxins & Furans in Stack Gas Emissions is 0.1 ng/Sm³ I-TEQ referenced to 11% O₂.

RESULTS – RELEASE POINT 4B – RUN 1 Continued

Table 25: Release Point 4B (Run 1) – Metals and their Compounds

Metal	Concentration (mg/Nm ³)	Emission Rate (g/min)
Antimony and its compounds	< 0.0003	< 0.001
Arsenic and its compounds	0.00011	0.00051
Barium (soluble compounds)	0.00081	0.0038
Beryllium and its compounds	< 0.0003	< 0.001
Cadmium and its compounds	< 0.00004	< 0.0002
Chromium (III) and its compounds	0.0025	0.012
Copper oxide fume (as CuO)	0.0012	0.0057
Iron oxide fume (as Fe ₂ O ₃)	0.31	1.5
Lead and its compounds	0.000075	0.00035
Magnesium oxide fume (as MgO)	0.039	0.18
Manganese and its compounds	0.0027	0.013
Mercury and its compounds (as Hg)		
Organic:	< 0.00004	< 0.0002
Inorganic:	0.0029	0.014
Total [†] :	0.0029	0.014
Nickel and its compounds	0.0014	0.0067
Zinc oxide fume (as ZnO)	0.0077	0.036
TOTAL METALS Excluding LOD values Including half LOD values	0.37	1.7

[†] Total does not include 'less than limit of detection' value for organic mercury.

RESULTS – RELEASE POINT 4B – RUN 1 Continued

Table 26: Release Point 4B (Run 1) – Individual USEPA Priority Pollutant PAHs

Individual USEPA Priority Pollutant PAHs	Concentration of PAHs ($\mu\text{g}/\text{Nm}^3$)	BaP-PEF value	BaP-TEQ Contribution	Emission Rate of PAHs (mg/min)
Naphthalene	15	0.0	0.0	71
2-Methylnaphthalene	1.4	0.0	0.0	6.6
Acenaphthylene	0.081	0.0	0.0	0.38
Acenaphthene	<0.01	0.0	0.0	<0.05
Fluorene	0.026	0.0	0.0	0.12
Phenanthrene	0.11	0.0	0.0	0.50
Anthracene	<0.01	0.0	0.0	<0.05
Fluoranthene	0.018	0.0	0.0	0.086
Pyrene	<0.01	0.0	0.0	<0.05
Benz(a)anthracene	<0.01	0.1	0.00054	<0.05
Chrysene	<0.01	0.01	0.000054	<0.05
Benzo(b)fluoranthene	<0.01	0.1	0.00054	<0.05
Benzo(k)fluoranthene	<0.01	0.1	0.00054	<0.05
Benzo(e)pyrene	<0.01	0.0	0.0	<0.05
Benzo(a)pyrene	<0.01	1.0	0.0054	<0.05
Perylene	<0.01	0.0	0.0	<0.05
Indeno(123-cd)pyrene	<0.01	0.1	0.00054	<0.05
Dibenz(ah)anthracene	<0.01	0.4	0.0022	<0.05
Benzo(ghi)perylene	<0.01	0.0	0.0	<0.05

Table 27: Release Point 4B (Run 1) – Total USEPA Priority Pollutant PAHs

Total USEPA Priority Pollutant PAHs	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
Excluding LOD values	17	78
Including half LOD values	17	78

Table 28: Release Point 4B (Run 1) – Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ^u	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
Excluding LOD values	0.0	0.0
Including half LOD values	0.010	0.047

^u Calculated using benzo(a)pyrene potency equivalency factors (BaP-PEF values).

RESULTS – RELEASE POINT 4B – RUN 1 Continued

Table 29: Release Point 4B (Run 1) – PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm ³)	WHO ₀₅ TEF	WHO ₀₅ TEQ contribution (ng/Nm ³)	NATO ₈₉ I-TEF	NATO ₈₉ I-TEQ contribution (ng/Nm ³)
2378 TCDF	0.0014	0.1	0.00014	0.1	0.00014
2378 TCDD	<0.00048	1	0.00024	1	0.00024
12378 PeCDF	0.0019	0.03	0.000058	0.05	0.000097
23478 PeCDF	0.0018	0.3	0.00053	0.5	0.00089
12378 PeCDD	<0.00043	1	0.00022	0.5	0.00011
123478 HxCDF	0.00070	0.1	0.000070	0.1	0.000070
123678 HxCDF	0.00081	0.1	0.000081	0.1	0.000081
234678 HxCDF	0.00051	0.1	0.000051	0.1	0.000051
123789 HxCDF	<0.00048	0.1	0.000024	0.1	0.000024
123478 HxCDD	<0.00038	0.1	0.000019	0.1	0.000019
123678 HxCDD	<0.00038	0.1	0.000019	0.1	0.000019
123789 HxCDD	<0.00038	0.1	0.000019	0.1	0.000019
1234678 HpCDF	0.0020	0.01	0.000020	0.01	0.000020
1234789 HpCDF	<0.00027	0.01	0.0000013	0.01	0.0000013
1234678 HpCDD	0.0050	0.01	0.000050	0.01	0.000050
OCDF	0.0025	0.0003	0.00000074	0.001	0.0000025
OCDD	0.12	0.0003	0.000037	0.001	0.00012
PCDD/F Homologue Groups				Concentration (ng/Nm³)	
Total TCDF isomers				0.038	
Total TCDD isomers				0.0052	
Total PeCDF isomers				0.024	
Total PeCDD isomers				0.0015	
Total HxCDF isomers				0.0070	
Total HxCDD isomers				0.0059	
Total HpCDF isomers				0.0037	
Total HpCDD isomers				0.011	
Polychlorinated Dioxins & Furans Results Summary				Concentration (ng/Nm³)	Emission Rate (µg/min)
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.22	1.0
Total PCDD/F (Including half LOD values)				0.22	1.0
WHO ₀₅ TEQ (Total of WHO ₀₅ TEQ contribution for 17 toxic congeners)					
WHO ₀₅ TEQ (Excluding LOD values)				0.0010	0.0049
WHO ₀₅ TEQ (Including half LOD values)				0.0016	0.0074
NATO ₈₉ I-TEQ (Total of NATO ₈₉ I-TEQ contribution for 17 toxic congeners)					
NATO ₈₉ I-TEQ (Excluding LOD values)				0.0015	0.0071
NATO ₈₉ I-TEQ (Including half LOD values)				0.0020	0.0092

RESULTS – RELEASE POINT 4B – RUN 2

Company	Adelaide Brighton Cement
Site	Elder Rd, Birkenhead
Source Tested	Precalciner Plant Stack - Release Point 4B
Date of Tests	19 th March 2020
Sampling Period	07:51 – 16:02
Testing Officers	I. Brash & M. Portnoy
Sampling Position	Four 4" BSP sample ports in circular stack

Table 30: Release Point 4B (Run 2) - Gas Flow Conditions

<i>Sampling Conditions</i>	Average
Stack diameter at sampling plane (m)	3.00
Average stack gas temperature (K)	374 (101 °C)
Average barometric pressure (mB)	1009.2
Static pressure (mB)	-1.74
Average stack pressure (mB)	1007.5
Average velocity at sampling plane (m/s)	18.3
Average velocity at sampling plane expressed at STP (m/s)	13.4
Actual gas flow rate (m ³ /min)	7,760
Average moisture content (%v/v)	16.3
Gas flow rate at STP, dry (Nm ³ /min)	4,740
Gas flow rate at STP, dry and referenced to 11% O ₂ (Sm ³ /min)	5,030
Average carbon dioxide concentration, dry basis (%v/v)	19.8
Average oxygen concentration (%v/v), dry basis	10.4
Dry molecular weight of stack gas (g/g mole)	31.58
Dry gas density of stack gas (kg/m ³)	1.409

RESULTS – RELEASE POINT 4B – RUN 2 Continued

Table 31: Release Point 4B (Run 2) - Summary of Test Results

Parameter	Sampling Period	Concentration (mg/Nm ³)	Emission Rate (g/min)
Total Solid Particulates	14:02 – 16:02 (19/03/2020)	3.6	17
PM ₁₀ Particles	14:02 – 16:02 (19/03/2020)	2.9	14
PM _{2.5} Particles		1.4	6.6
Sulphur Dioxide	08:20 – 09:20 (19/03/2020)	<3	<10
Carbon Monoxide		490	2,320
Oxides of Nitrogen (as NO ₂) <i>Actual at STP</i>		500	2,370
Hydrogen Chloride		0.67	3.2
Chlorine	08:49 – 09:49 (19/03/2020)	0.17	0.80
Fluoride (as HF)		<0.2	<1
Total Volatile Organic Compounds (by FIA, as n-propane equivalent)	12:18 – 13:18 (19/03/2020)	2.4	11
Benzene (by activated carbon adsorption and GC/MS analysis)		<0.09	<0.4
Total Multi-Metals ^v	14:02 – 16:02 (19/03/2020)	0.40	1.9
Chromium VI and Compounds	11:36 – 13:36 (19/03/2020)	0.00082	0.0039
Polycyclic Aromatic Hydrocarbons <i>Total BaP-TEQ_{PAH}</i> ^w	07:51 – 10:51 (19/03/2020)	0.000010	0.000047
Polychlorinated Dioxins and Furans ^x		0.062 ng/Nm ³	0.29 µg/min
Total tetra to octa PCDDs/Fs ^y		0.00079 ng/Nm ³	0.0037 µg/min
WHO ₀₅ TEQ for PCDDs/Fs ^j		0.00082 ng/Nm ³	0.0039 µg/min
NATO ₈₉ I-TEQ for PCDDs/Fs ^j			

Table 32: Comparison of Dioxin & Furan Concentration in 4B Stack (Run 2) with International Guideline

Parameter	Concentration in Stack Gas Emissions (ng/Nm ³)	Oxygen (O ₂) Reference Condition (%)	Concentration at O ₂ Reference Condition (ng/Sm ³)	International Guideline (ng/Sm ³) ^z	Compliance with International Guideline
Polychlorinated Dioxins & Furans (NATO ₈₉ I-TEQ)	0.00082	11	0.00078	0.1	YES

^v Individual metals and their compounds are given in Table 33. Total solid particulates were determined in conjunction with multi-metals, as the sampling procedure for the particulate phase of the metals train by USEPA 29 is identical to AS 4323.2 (refer to Table 2 'Summary of Test Methods').

^w Individual BaP-TEQ_{PAH} contributions are given in Table 34, and the total BaP-TEQ_{PAH} in Table 36. This result includes half LOD values.

^x Tetra-octa chlorinated dioxin & furan congener profile, homologue groups and toxic equivalents are given in Table 37.

^y Result includes half LOD values.

^z The International Guideline for the Concentration of Polychlorinated Dioxins & Furans in Stack Gas Emissions is 0.1 ng/Sm³ I-TEQ referenced to 11% O₂.

RESULTS – RELEASE POINT 4B – RUN 2 Continued

Table 33: Release Point 4B (Run 2) - Metals and their Compounds

Metal	Concentration (mg/Nm³)	Emission Rate (g/min)
Antimony and its compounds	0.000071	0.00034
Arsenic and its compounds	0.00024	0.0011
Barium (soluble compounds)	0.0022	0.011
Beryllium and its compounds	< 0.0003	< 0.001
Cadmium and its compounds	< 0.00004	< 0.0002
Chromium (III) and its compounds	0.0024	0.011
Copper oxide fume (as CuO)	0.012	0.056
Iron oxide fume (as Fe ₂ O ₃)	0.19	0.90
Lead and its compounds	0.00054	0.0026
Magnesium oxide fume (as MgO)	0.059	0.28
Manganese and its compounds	0.10	0.49
Mercury and its compounds (as Hg)		
Organic:	0.000074	0.00035
Inorganic:	0.0028	0.013
Total:	0.0029	0.014
Nickel and its compounds	0.0047	0.022
Zinc oxide fume (as ZnO)	0.022	0.10
TOTAL METALS Excluding LOD values Including half LOD values	0.40	1.9

RESULTS – RELEASE POINT 4B – RUN 2 Continued

Table 34: Release Point 4B (Run 2) – Individual USEPA Priority Pollutant PAHs

Individual USEPA Priority Pollutant PAHs	Concentration of PAHs ($\mu\text{g}/\text{Nm}^3$)	BaP-PEF value	BaP-TEQ Contribution	Emission Rate of PAHs (mg/min)
Naphthalene	14	0.0	0.0	65
2-Methylnaphthalene	0.79	0.0	0.0	3.7
Acenaphthylene	0.041	0.0	0.0	0.19
Acenaphthene	<0.01	0.0	0.0	<0.05
Fluorene	0.033	0.0	0.0	0.15
Phenanthrene	0.084	0.0	0.0	0.40
Anthracene	<0.011	0.0	0.0	<0.05
Fluoranthene	0.022	0.0	0.0	0.10
Pyrene	<0.01	0.0	0.0	<0.05
Benz(a)anthracene	<0.01	0.1	0.00053	<0.05
Chrysene	<0.01	0.01	0.000053	<0.05
Benzo(b)fluoranthene	<0.01	0.1	0.00053	<0.05
Benzo(k)fluoranthene	<0.01	0.1	0.00053	<0.05
Benzo(e)pyrene	<0.01	0.0	0.0	<0.05
Benzo(a)pyrene	<0.01	1.0	0.0053	<0.05
Perylene	<0.01	0.0	0.0	<0.05
Indeno(123-cd)pyrene	<0.01	0.1	0.00053	<0.05
Dibenz(ah)anthracene	<0.01	0.4	0.0021	<0.05
Benzo(ghi)perylene	<0.01	0.0	0.0	<0.05

Table 35: Release Point 4B (Run 2) – Total USEPA Priority Pollutant PAHs

Total USEPA Priority Pollutant PAHs	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
Excluding LOD values	15	70
Including half LOD values	15	70

Table 36: Release Point 4B (Run 2) – Total PAH Toxic Equivalents (BaP-TEQ_{PAH})

Total PAH Toxic Equivalents (BaP-TEQ _{PAH}) ^{aa}	Concentration ($\mu\text{g}/\text{Nm}^3$)	Emission Rate (mg/min)
Excluding LOD values	0.0	0.0
Including half LOD values	0.010	0.047

^{aa} Calculated using benzo(a)pyrene potency equivalency factors (BaP-PEF values).

RESULTS – RELEASE POINT 4B – RUN 2 Continued

Table 37: Release Point 4B (Run 2) – PCDD/F Congener Profile

PCDD/F Congeners	Concentration (ng/Nm ³)	WHO ₀₅ TEF	WHO ₀₅ TEQ contribution (ng/Nm ³)	NATO ₈₉ I-TEF	NATO ₈₉ I-TEQ contribution (ng/Nm ³)
2378 TCDF	<0.00053	0.1	0.000026	0.1	0.000026
2378 TCDD	<0.00053	1	0.00026	1	0.00026
12378 PeCDF	0.00040	0.03	0.000012	0.05	0.000020
23478 PeCDF	0.00043	0.3	0.00013	0.5	0.00022
12378 PeCDD	<0.00032	1	0.00016	0.5	0.000079
123478 HxCDF	0.00025	0.1	0.000025	0.1	0.000025
123678 HxCDF	0.00031	0.1	0.000031	0.1	0.000031
234678 HxCDF	0.00026	0.1	0.000026	0.1	0.000026
123789 HxCDF	<0.00032	0.1	0.000016	0.1	0.000016
123478 HxCDD	<0.00026	0.1	0.000013	0.1	0.000013
123678 HxCDD	<0.00026	0.1	0.000013	0.1	0.000013
123789 HxCDD	<0.00026	0.1	0.000013	0.1	0.000013
1234678 HpCDF	0.0017	0.01	0.000017	0.01	0.000017
1234789 HpCDF	0.00034	0.01	0.0000034	0.01	0.0000034
1234678 HpCDD	0.0037	0.01	0.000037	0.01	0.000037
OCDF	0.0017	0.0003	0.00000051	0.001	0.0000017
OCDD	0.021	0.0003	0.0000063	0.001	0.000021
PCDD/F Homologue Groups				Concentration (ng/Nm³)	
Total TCDF isomers				0.014	
Total TCDD isomers				0.0017	
Total PeCDF isomers				0.0063	
Total PeCDD isomers				0.0012	
Total HxCDF isomers				0.0028	
Total HxCDD isomers				0.0024	
Total HpCDF isomers				0.0034	
Total HpCDD isomers				0.0074	
Polychlorinated Dioxins & Furans Results Summary				Concentration (ng/Nm³)	Emission Rate (µg/min)
Sum of PCDD/F congeners (Total of all Tetra to Octa congeners)					
Total PCDD/F (Excluding LOD values)				0.062	0.29
Total PCDD/F (Including half LOD values)				0.062	0.29
WHO ₀₅ TEQ (Total of WHO ₀₅ TEQ contribution for 17 toxic congeners)					
WHO ₀₅ TEQ (Excluding LOD values)				0.00029	0.0014
WHO ₀₅ TEQ (Including half LOD values)				0.00079	0.0037
NATO ₈₉ I-TEQ (Total of NATO ₈₉ I-TEQ contribution for 17 toxic congeners)					
NATO ₈₉ I-TEQ (Excluding LOD values)				0.00040	0.0019
NATO ₈₉ I-TEQ (Including half LOD values)				0.00082	0.0039

END OF REPORT